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DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

PEBBLE PHOSPHATE ACCIDENT EXPERIENCE

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BY

FRANK E. CASH AND CLAUD P. DEMPSEY

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DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

PEBBLE PHOSPHATE ACCIDENT EXPERIENCE[1]

By Frank E. Cash[2] and Claud P. Dempsey[3]

INTRODUCTION

The data in this circular were compiled so that individual phosphate companies might have the benefit of the experience of other phosphate companies, and that industries in general might compare experiences (taking into consideration relative hazards), thereby promoting accident prevention.

ACKNOWLEDGMENTS

The descriptive matter is taken in part from a paper by Cash and von Bernewitz.[4] Production figures are from Mineral Resources of the United States;[5] accident data were furnished by each of the operating companies in the pebble-phosphate district, and their assistance in making this report possible is gratefully acknowledged.

MINING DISTRICT

Most of the land pebble-phosphate district of Florida is in the western part of Polk County and the eastern part of Hillsborough County, but it extends south into the northwest corner of DeSoto County and the northeast corner of Manatee County. The area now considered workable extends from near Plant City on the north almost to Bowling Green on the south -- 30 miles in a northwest and southeast direction, with an average width of 10 miles.

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[1] The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6917."

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[4] Cash, F. E., and von Bernewitz, M. W., Methods, Costs, and Safety in Stripping and Mining Coal, Copper Ore, Iron Ore, Bauxite, and Pebble Phosphate: Bull. 298, Bureau of Mines, 1929, 275 pp.

[5] Bureau of Mines, Mineral Resources of the United States, 1925-1931 (prior to 1925 data assembled by the U. S. Geol. Survey); Minerals Yearbook, 1932-33 and 1934.

The Atlantic Coast Line Railroad and the Seaboard Air Line Railway operate through the field, giving transportation facilities to inland and seaboard points for proper handling of coastwise and export trade.

PRODUCTION

The producing companies in the district are The American Agricultural Chemical Co., Pierce; American Cyanamid Co., Brewster; Coronet Phosphate Co., Plant City; International Agricultural Corp., Mulberry; Phosphate Mining Co., Nichols; Southern Phosphate Corp., Bartow; Swift & Co., Fertilizer Works, Agricola.

Production of land pebble phosphate in Florida was begun in 1890; the first shipment was made in 1891; and at present, under normal conditions, annual shipments are between two and three million long tons.[6]

Florida produces approximately 85 percent of the phosphate mined in the United States, and 95 percent of the Florida production is from the pebble-phosphate district.

MINING METHODS

The phosphate conglomerate or matrix is overlain by 10 to 50 feet of sand, sandy clay, or porous, friable sandstone, which constitute the overburden. The overburden is removed either by traction, electric dragline excavators with 120- to 160-foot booms and 6- to 10-cubic yard buckets, and "spoiled" in areas from which the matrix has been mined, or it is removed hydraulically.

The matrix, which is 5 to 20 feet thick, is mined by hydraulic giants or "guns" that have a nozzle pressure of 170 to 220 pounds per square inch. Before mining is begun it is necessary to have a well, sump, or low place in which to accumulate the dislodged matrix to be picked up by the pumps. These wells or sumps are made by the excavator or by water pressure or are drill blasted. After the sump is prepared and the pump connected the bed of matrix is cut down by the hydraulic guns, flows into the sump, and is picked up by 10- and 12-inch centrifugal pumps driven directly by electric motors handling 10 to 25 percent solids and using from 2,500 to 4,000 gallons of water. If the height or distance between sump and washer becomes too great, one or more relay or booster pumps are placed in the line between the pit and washer.

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[6] See footnote 5.

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WASHING AND DRYING

The matrix is discharged into processing plants called washers, in which it is dewatered, processed to remove slimes and clay, and screened to remove the sand and small pebbles of phosphate. The rejected fines are reclaimed later by flotation, and the washed phosphate pebbles are loaded into cars and hauled by steam or electric locomotives to the drying plant. The rock is dried in oil-fired rotary kilns at an average temperature of 225° F. at the discharge end and conveyed by belts to classified storage bins, from which shipments are made.

SAFETY ORGANIZATIONS

Each of the companies in the pebble-phosphate district has safety directors and employees' safety organizations that hold regular periodical meetings. Previous accidents and near accidents are discussed in these meetings and suggestions are made for the prevention of future similar accidents; also, employees are encouraged to make suggestions for the improvement of living and working conditions in and around the mines and plants.

One of the oldest and most active Holmes chapters in the United States is functioning in one of these mining communities, and all matters pertaining to safety are handled by the chapter.

Annual first-aid contests are held in the district, and although all of the companies are not represented by teams they are represented by interested spectators and eventually will enter teams. The majority of the companies maintain 100-percent first-aid-trained organizations, and all of them have some if not all employees trained annually.

ACCIDENT EXPERIENCE

Data were made available by the seven operating companies--six for a 5-year period and one for a 4-year period. To present these data on a comparable basis the total days lost will be increased in some instances, as partial permanent disabilities are carried in the district as actual days lost and fatal accidents are charged by two companies without loss of time.

The partial and total permanent-disability and fatal-accident figures uniformly comparable with those for other industries have been converted into their equivalent of days lost according to the Scale of Time Losses for Weighting Deaths and Permanent Injuries to Show Severity of Injuries, used by the United States Bureau of Mines. (See table 1.)

TABLE 1. - Scale of time losses for weighting deaths and permanent injuries so as to show severity of injuries [1]

Nature of injury[2]	Degree of disability, in percent of permanent total disability	Days lost
Death	100	6,000
Permanent total disability	100	6,000
Arm above elbow, dismemberment or loss of use of	75	4,500
Arm at or below elbow, dismemberment or loss of use of	60	3,600
Hand, dismemberment or loss of use of	50	3,000
Thumb, dismemberment or loss of use of	10	600
Any 1 finger, dismemberment or loss of use of	5	300
2 fingers, dismemberment or loss of use of	12½	750
3 fingers, dismemberment or loss of use of	20	1,200
4 fingers, dismemberment or loss of use of	30	1,800
Thumb and 1 finger, dismemberment or loss of use of	20	1,200
Thumb and 2 fingers, dismemberment or loss of use of	25	1,500
Thumb and 3 fingers, dismemberment or loss of use of	33-1/3	2,000
Thumb and 4 fingers, dismemberment or loss of use of	40	2,400
Leg above knee, dismemberment or loss of use of	75	4,500
Leg at or below knee, dismemberment or loss of use of	50	3,000
Foot, dismemberment or loss of use of	40	2,400
Great toe, or any 2 or more toes, dismemberment or loss of use of	5	300
1 toe, other than great toe, dismemberment or loss of use of	0	.....
1 eye, loss of sight	30	1,800
Both eyes, loss of sight	100	6,000
1 ear, loss of hearing	10	600
Both ears, loss of hearing	50	3,000

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[1] Bureau of Mines, Rules Governing the Award of Trophies in the National Safety Competition for 1936, p. 3.

[2] Dismemberment

Tables 2 to 5, inclusive, contain accident figures for the various phosphate companies by months, age of injured, and nature and causes of injuries; table 6 consolidates these figures for the pebble phosphate industry.

TABLE 2. - Accidents by months, 1930-34

Month	Company							Total
	A	B	C	D1/	E	F	G	
January	9	18	3	5	...	9	4	48
February	2	7	4	4	...	5	1	23
March	3	9	3	5	...	11	2	33
April	4	13	2	2	...	9	2	32
May	4	12	1	3	...	10	2	32
June	1	8	4	2	...	10	1	26
July	4	7	1	9	...	12	4	37
August	2	4	2	3	...	11	6	28
September	3	12	1	5	...	9	7	37
October	2	8	3	3	...	10	4	30
November	2	2	0	4	...	10	6	24
December	2	11	4	3	...	10	1	31
Total	38	111	28	48	...	116	40	381

1/ 4 years, 1931-34.

TABLE 3. - Age of injured, 1930-34

Age	Company							Total
	A	B	C	D	E	F	G	
18-28	9	33	8	12	...	...	13	75
28-38	13	35	6	16	...	...	15	85
38-48	15	28	11	9	...	...	11	74
48-58	1	13	2	9	...	...	1	26
58-68	0	2	1	2	...	...	0	5
Over 68	0	0	0	0	...	...	0	0
Total	38	111	28	48	...	...	40	265

Table 2 gives the accidents, by months, for six of the seven companies. One of the companies, E, did not separate the no-lost-time accidents from the lost-time accidents. Data for company D cover the four years 1931-34, while those for companies A, B, C, F, and G cover the five years, 1930-34.

The total number of lost-time accidents was 381, and the average per month 31.75; for the entire period the greatest number of accidents occurred in January and the smallest number in February.

Table 3 lists the number injured during 1930-34 according to 10-year age periods from the employable age of 18 years. Injuries apparently occur uniformly in proportion to the numbers employed in the various age groups.

Table 4 includes data on the part of the body injured from six of the seven companies.

TABLE 4. - Nature of injuries

Injury	Company							Total
	A	B	C	D	E	F	G	
Head	1	1	1	0	0	...	2	5
Face	1	6	0	2	2	...	1	12
Eyes[1]	6	5	2	[1]3	3	...	2	21
Shoulder	1	7	0	0	0	...	0	8
Arm	1	3	3	2	2	...	2	13
Wrist and hand	4	5	2	3	1	...	1	16
Fingers	4	18	4	0	10	...	[1]5	41
Chest	2	9	2	3	2	...	1	19
Back	1	6	1	14	5	...	4	31
Pelvis	0	0	0	0	0	...	1	1
Groin	0	2	0	0	2	...	0	4
Hip	1	0	0	1	0	...	0	2
Thigh	1	0	0	0	0	...	0	1
Leg	4	7	1	3	5	...	1	21
Knee	1	6	2	5	1	...	4	19
Ankle	1	6	1	5	2	...	1	16
Foot	6	22	6	6	4	...	12	56
Toes	2	4	1	1	0	...	1	9
Internal	0	3	2	0	0	...	0	5
Heat	0	0	0	0	0	...	1	1
Fatal	1	1	0	0	1	...	1	4
Total	38	111	28	48	40	...	40	305

[1] Partial permanent.

There were four fatalities among all companies for the 5-year period - one caused by automotive equipment and three by electricity. Five partial permanent disabilities that resulted from accidents caused the loss of an eye in one case, an arm in another, and of fingers in three cases; 296 other accidents resulted in lost time.

Although it was possible to segregate, from three of the plants, only the days lost for injury to specific parts of the body, the average days lost per accident were: For injury to arm, 634.6 days, including 1 with partial permanent disability; for injury to eyes, 122.4 days, including loss of sight of one eye; for injury to head, 43 days; to fingers, 37.8

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days, including three with partial permanent disability; to ankle, 23.3 days; to leg, 18.5 days; to toes, 17.5 days; to wrist and hand, 16.9 days; to chest, 12.5 days; to groin, 12.5 days; for internal injury, 12 days; for injury to hip, 12 days; to foot, 11.1 days; to shoulder, 9.8 days; to knee, 8 days; to back, 6.7 days; to face, 4.6 days; and to thigh, 2 days.

The parts of the body most frequently injured were: Feet, 57 accidents; fingers, 40; back, 31; legs, 22; eyes, 21; chest, 30; and other parts of the body, 1 to 18 accidents. The above figures do not include 116 lost-time accidents among employees of one of the operating companies.

In table 5 the accidents from six of the seven operations are tabulated by causes. Handling material caused the greatest number of accidents (49), machinery was second with 46, and falling persons third with 42. One of the fatalities was due to automotive equipment and three to electricity.

TABLE 5 - Classification of accident causes

Causes	Company							Total
	A	B	C	D	E	F	G	
Handling material...	7	0	5	15	10	...	12	49
Machinery	4	17	6	10	4	...	5	46
Falling	3	17	3	8	5	...	6	42
Hand tools	3	8	4	5	8	...	3	31
Falling material ...	2	23	...	...	...	...	2	27
Haulage	1	7	...	4	8	...	1	21
Nails, etc.	4	8	1	1	1	...	...	15
Burns	2	5	...	4	...	...	2	13
Electricity	...	7	...	1	2	...	3	13
Flying material	4	2	5	...	...	...	...	11
Infections	...	...	4	...	...	...	2	6
Automotive equipment	5	...	...	...	...	...	...	5
Struck object	2	...	...	...	...	...	1	3
Explosives	1	...	...	...	...	...	1	2
Miscellaneous	...	17	...	...	2	...	2	21
Total	38	111	28	48	40	...	40	305

The accident experience for the pebble-phosphate industry is given in table 6 by companies for the 5-year period. The last column of the table gives the average number of plants operated (mines, washers, driers, and flotation plants), men employed annually, and total number of lost-time accidents, man-hours of exposure, days lost, production, and the combined frequency and severity rates.

TABLE 6. - Accident experience, pebble-phosphate industry, 1930-34

Company	A	B	C	1/ D	E	F	G	Total
Number of mines, washers, and plants	6	8	5	5	3	5	7	39
Average number of men	245	388	126	240	65	193	295	1,552
Man-hours of exposure	2,835,944	5,933,953	1,341,853	1,671,604	745,142	2,563,040	3,903,861	18,995,346
Number of lost-time accidents, all causes	38	111	28	48	40	116	40	421
Number of days lost, all accidents	6,932	11,374	239	2,371	6,579	7,214	7,248	41,957
Production (long tons)	-	-	-	-	-	-	-	10,884,662
Frequency	13.39	18.71	20.86	28.76	53.68	45.29	10.24	22.05
Severity	2.44	1.93	0.18	1.42	8.80	2.81	1.84	2.21

1/ 4 years, 1931-34.

In Table 7 the frequency and severity rates for all industries are compared by years with those for the pebble-phosphate industry by years from 1930 to 1934, inclusive.

TABLE 7. - Accident frequency and severity rates for all industries[1] and for the pebble-phosphate industry, 1930-34

Year	Severity rate		Frequency rate	
	All industries	Pebble phosphate	All industries	Pebble phosphate
1930	1.97	0.24	18.47	19.38
1931	1.72	1.74	15.12	24.96
1932	1.59	2.05	13.20	14.27
1933	1.59	3.89	14.56	24.26
1934	1.70	3.76	15.29	23.45

[1] Figures taken from Accident Facts, issued by the National Safety Council for the years listed.

SUMMARY

The pebble-phosphate mining companies, realizing the humane side of accidents, work on the basis that if phosphate is to be produced efficiently it must be produced safely. This is not simply a slogan but an actual every-day operating practice. The best available medical attention is provided, individual employees are required to report for treatment of all injuries however slight, and their health and that of their families is guarded carefully.

Each company has a safety director or inspector; and, in addition, each supervisor must endeavor to work without accidents and must require the men under his supervision to endeavor to do so also. Safety meetings are conducted by the safety director or inspector; all officials and employees must attend unless there is good reason for absence. The meetings are not dominated by the safety director, the operating officials, or the men; safe operating practices are discussed, the employees feel their responsibility and express their opinions and views on an equality with the operating officials, and decisions are reached and enforced with the full approval and support of all parties concerned.

The pebble-phosphate industry has a much more favorable accident experience than the general mining industry, frequency being about one-third that of mining for the past 5 years and severity about one fourth as great. With an average frequency rate of 22.05 and an average severity rate of 2.81 for a 5-year period, the industry is and has a right to be proud, but feels that the number of accidents can be reduced further and is determined to improve its accident experience.

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CONCLUSIONS

Accidents in the pebble-phosphate district can and no doubt will be reduced to a much lower or better figure. It is believed this can be accomplished by more permanent mine and washer construction and more thorough and detailed training and instruction of individual employees.